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Mapping the decision points and climate information use of agricultural producers across the U.S. Corn Belt

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ABSTRACT

The usefulness of climate information for agricultural risk management hinges on its availability and relevance to the producer when climate-sensitive decisions are being made. Climate information providers are challenged with the task of balancing forecast availability and lead time with acceptable forecast skill, which requires an improved understanding of the timing of agricultural decision making. Achieving a useful balance may also require an expansion of inquiry to include use of non-forecast climate information (i.e. historical climate information) in agricultural decision making. Decision calendars have proven valuable for identifying opportunities for using different types of climate information. The extent to which decision-making time periods are localized versus generalized across major commodity-producing regions is yet unknown, though, which has limited their use in climate product development. Based on a 2012 survey of more than 4770 agricultural producers across the U.S. Corn Belt region, we found variation in the timing of decision-making points in the crop year based on geographic variation as well as crop management differences. Many key decisions in the cropping year take place during the preceding fall and winter, months before planting, raising questions about types of climate information that might be best inserted into risk management decisions at that time. We found that historical climate information and long term climate outlooks are less influential in agricultural risk management than current weather, short term forecasts, or monthly climate projections, even though they may, in fact, be more useful to certain types of decision making.

Introduction

Agricultural production in the U.S. Corn Belt depends upon favorable weather, and climate variability affects agricultural decisions and outcomes at many points throughout the year (Motha and Baier, 2005; Andresen et al., 2012). Producers'

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forecast "horizons" of interest (e.g., drought next month, early frost next fall, El Niño next growing season) change throughout the year and may focus on different weather variables. Climate outlooks and historical climate information should therefore be valuable to agricultural producers for decision making and risk management (Mjelde, 1986; Keating et al., 1993; Hammer et al., 1996; Cabrera et al., 2007; Selvaraju, 2012). Scholars have suggested that producers' successful adaptation to future climate variability and change will depend upon increasing their use of climate information (Meinke and Stone, 2005). In fact, a key message of the agriculture chapter of the recent U.S. National Climate Assessment (Melillo et al., 2014) states that "*…increased innovation will be needed to ensure the rate of adaptation of agriculture and the associated socioeconomic system can keep pace with future climate change*."

Yet, interestingly, agricultural decision makers have not widely adopted the use of climate information in their risk management decisions (Ash et al., 2007; Livezey and Timofeyeva, 2008; Lemos et al., 2012), which leads researchers to question what can be done to improve the perceived value and use of climate information in agricultural risk management. While a large body of research focuses on improving forecast skill (Hoskins, 2013; Magnusson and Källén, 2013), other characteristics of the forecast such as lead time or the context in which decisions are made may be just as important in increasing its use (Mjelde, 1986; Easterling and Mjelde, 1987; Hammer, 2000; Letson et al., 2005; Meinke and Stone, 2005; Cabrera et al., 2007; Asseng et al., 2012). Agricultural producers make decisions on multiple time-scales, ranging from operational decisions (which will be carried out in the next few days) to tactical decisions (carried out in future weeks or months) and strategic decisions (carried out in future seasons or years or beyond) (Hollinger, 1991). Opportunities for inserting climate information into tactical and strategic management depend on the availability of relevant information when those decisions are being made (Easterling and Mjelde, 1987; Changnon et al., 1988; Sonka et al., 1988; Hansen, 2002; Mase and Prokopy, 2014). For this reason, lead time may one of the most important aspects of climate forecast usefulness (Easterling and Mjelde, 1987; Sonka et al., 1988). The challenges in balancing acceptable lead time with an acceptable level of skill call for a better understanding of when specific types of climate information are needed by agricultural decision makers.

Decision calendars help identify opportunities for inserting climate information into a decision process as well as points where other considerations might overrule use of the climate information (Changnon et al., 1988; Pulwarty and Melis, 2001; Wiener, 2004; Corringham et al., 2008; Takle et al., 2014). A decision calendar is developed around the assumption that the timing of decisions and management practices is "cyclical and recurrent" (Aubry et al., 1998; Dounias et al., 2002). Developers of decision calendars are challenged, though, by a potentially infinite number of modifications required to address spatial variability in agricultural decision making. Variability in climate, soils, and agricultural production systems across a region may result in deviations in decision-making times. For example, Takle et al. (2014) developed a prototype of a climate-based decision calendar for corn production for the central U.S. Corn Belt region (Iowa, northern Illinois, and northern Indiana). Whether the calendar represents decision timing across the broader U.S. Corn Belt is examined here.

The Takle et al. (2014) calendar presumes decisions must consider both natural variability within climate normals and departures from past norms. Therefore, both historical climate information and a forecast of future climate are needed for the decision to be optimum. The use of historical climate information appears to be less examined in the literature than the use of climate forecasts. Changnon et al. (1988) and Sonka et al. (1988) found agribusiness professionals (e.g., seed corn company decision makers) incorporated historical climate information into their decision-making more often than climate outlooks, yet placed a higher value on predictions than on historical information. A better understanding is needed regarding the ways farm decision makers are influenced by, and could potentially use, historical climate information together with climate forecast and climate change information.

In this paper, we explore U.S. Corn Belt farmers' use of climate information and how that information fits into the timing of tactical decisions at the heart of on-farm management of climate risk, including input purchases, seeding rate, tillage, insurance, cover crops, and propane purchase for grain drying. We use our findings to describe implications for developing usable climate information tailored to agricultural risk management.

Materials/methods

The U.S. Corn Belt is a commodity-producing region that spans an area of significant climatic, geological, and vegetative gradients. The Modified Köppen classifications for the area range from semi-arid steppe (Bsk) across far western sections to microthermal humid continental mild summer (Dfb) across northern sections to microthermal humid continental hot summer (Dfa) elsewhere. Average annual temperature varies by about 8 °C across the region, from just under 6 °C in central Minnesota to more than 13 °C in southern Illinois and Indiana. Base 10 °C seasonal growing degree day totals, a temperature-derived index of time spent above the 10 °C-threshold that is used to quantify thermal crop requirements, range from around 1400 in central Minnesota to more than 2250 in southern Illinois. Average annual precipitation generally increases from west to east across the region, ranging from about 400 mm in western Nebraska to more than 1200 mm in southern Indiana. Precipitation in the Corn Belt occurs in all months and seasons, with some seasonality that varies from east to west across the region. Soils across the Corn Belt also vary widely, including loess-dominated soils across most western and central sections of the region, alluvial soils near major rivers, and coarse-textured soils elsewhere. Northeastern soils are highly heterogeneous resulting from repeated glaciations, while southeastern soils are relatively old, homogeneous, and highly weathered (Andresen et al., 2012).